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Smart Air Purifier with Air Quality Monitoring System

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Abstract: ***The project presents the concept, functional physical model of an air purification system for small public spaces or apartments. The purifier is controlled by a microcontroller of the Arduino UNO series. The model is equipped with a set of sensors which are used to determine the air quality. After exceeding the adopted threshold in the software, the system automatically starts the process of air filtering. The air purification system depends on the optical dust sensor readings as it senses the quality of air in the room and turns the air purifier On and Off accordingly. The body of the air purifier is made by wood and filters. The filters used are pre-filter, dust-filter & fine-filter. The purifier absorbs solid pollutants and reduces VOC pollutants. The system has been equipped with an LCD screen informing the user about the air parameters and the quality of air being purified.***

Keywords: AP-Air Purifier

I. INTRODUCTION

The presence of dust in homes, offices, and other human environments are unavoidable. In fact, according to the Environmental Protection Agency, indoor air can be 2 to 5 times more polluted than outdoor air. This airborne pollution contributes to minor annoyances such as itchy eyes, sneezing, and headaches to human beings. Worst still, it can be a major contributing factor to severe allergies & life-threatening asthma. To solve this problem, a working air purification system will address this issue. I would like to leverage the advantages of sensors and to make the air purifier smarter. Instead of the conventional way that turning on the air purifier whole day, but with the use of "microcontroller" and "sensor" to operate only if the presence of dust reach certain level of awareness, this could save a lot of electricity and also keep the room, apartment, not only clean the air pollutants in the room but also monitors the quality of air been purified at the particular instant of time .Air Pollution is an increasing problem in the 21st Century. It is one of the main causes for climate change and it can cause a lot more problems in the future. Hence, our group decided to design an air purifier that can be installed in any room of your house, in the ICU of a Hospital or in our college for that matter. By using some basic sensors with our air purifier, the power consumption becomes less hence it is very important element. Next, we are building an air quality monitoring system using some basic sensors.

II. DESIGN OF AIR PURIFIER

The architecture of the proposed AP is presented in Fig.1

Fig 1: Architecture of the AP

A. Mechanical Design

The Air Filter has five slots, three slots for the filters on the fan intake, a slot for the box fan and a slot for the filter on the fan exhaust. The fan used in the Air Filter is a standard box fan with the rough dimensions of 8” X 8” X 4”. The filters are 8” X 8” X 1”. The intake filters are the least expensive ones that could be found. The fine filter is the better filter to catch the finer particles.

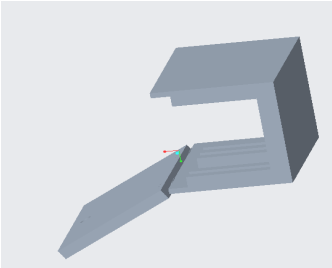

Fig 2: Visualization of the PAP’s body.

The most efficient way of using passive filters requires airflow to pass evenly through the entire filter instead of being pushed through its middle. In this way filter life is extended and the effective filtration time of the air purifier is increased. In order to fulfil these two tasks, the speed and direction of the airflow must be predefined. This is achieved using a powerful fan

B. Filtering Part

The filtering stages are shown in Fig. 3.

DUST FILTER PRE FILTER FINE FILTER

FIG 3: FILTERING STAGES

Air is filtered in the following steps:

1) Air is sucked through the opening in the front panel of Air Purifier and is guided to the first filter.
2) The first filter is the so called the 'Dust Filter' & its main function is to remove the big particles present in the air. It removes the particles of 3 to 10 micron size.
3) The second filter is the so called 'Pre Filter' & its main function is to absorb the air contaminants such as hairs and other matter visible to the naked eye. It removes particles of size 10 to 25 micron size.
4) The last filter is the Fine filter, which removes most of the particles with a diameter larger or equal to 1 to 3 micron size.

C. Electronic Design

1) Sensors

a) MQ 135 - Air quality sensor for detecting a wide range of gases, including NH3, NOx, alcohol, benzene, smoke and CO2. Ideal for use in office or factory. MQ135 gas sensor has high sensitivity to Ammonia , Sulphide and Benze steam, also sensitive to smoke and other harmful gases. It is with low cost and particularly suitable for Air quality monitoring application.

2) Features

a) High Sensitivity
b) High sensitivity to Ammonia, Sulfide and Benze
c) Stable and Long Life
d) Detection Range: 10 - 300 ppm NH3, 10 - 1000 ppm Benzene, 10 - 300 Alcohol
e) Heater Voltage: 5.0V
f) Dimensions: 18mm Diameter, 17mm High excluding pins, Pins - 6mm High
g) Long life and low cost.

3) The Microprocessor and the Display Module: The microprocessor used in the hardware design is the 3.3V 8MHz version of the Arduino Uno, and the display module is HD44780U dot-matrix LCD screen.

4) Hardware Interconnections:Connections between the modules are illustrated in Fig , the Relay module is powered at 230V which operates the fan and by stepping down the voltage it operates the Arduino Uno at 5V.

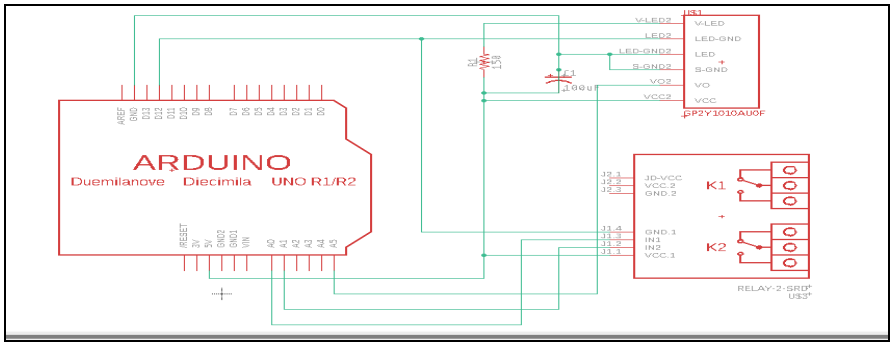

Fig 4 : Dust Sensor Circuit

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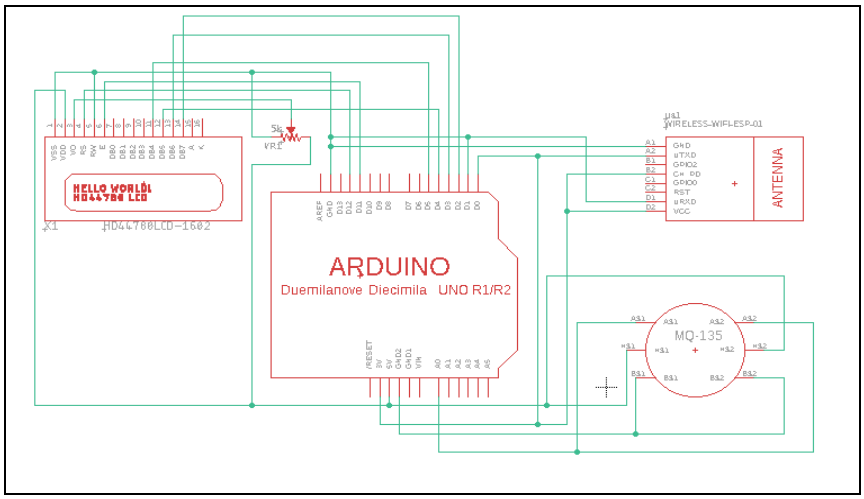

Fig 5: Air Quality Monitoring System Circuit

Table 1: Characteristics of AP

Air Purifier Properties	Value
Length(in)	17
Height(in)	10
Width(in)	1
Mass(kg)	5
Power Supply- 1.Relay Module 2.Arduino Uno	 230V , 10A 5V , 2.1A0

D. Mathematical system calculation

The important factor in the air purifier is determining the size of the room for the selection of the components. The size of the is determined according to the value of cfm (cubic feet per minute) and then fan for air purifier is selected from same value of cfm of room. The cfm of fan is determined from rpm of fan. Equation (1) and (2) are given by

CFM= (L x W x H x Q)/60 min (referring [9]) □□ (□)
L= Length of room (sq ft)
W= Width of room (sq ft)
H= Height of room (sq ft)
Q = Air Flow rate
CFM = 3.1416(PI) X (0.5- S) X R X A ..(2)
S = Square feet radius of fan (sq ft)
R = Rpm of fan (rad/s)
A = Area of fan
The Calculations Of The Air Purifier In The Project Are As Follows:-

1) The Measurements Of Room Is Given In Order To Determine CFM

L = 20 SQ FT, W = 20 SQ FT, H= 20 SQ FT, Q = 4
CFM= (L X W X H X Q)/60 MIN
CFM = (20 X 20 X 20 X 4)/60
CFM = 32000/60
CFM = 533.33
THE CFM OF SELECTED ROOM IS 533.33

2) The Measurement OF CFM of Fan FROM RPM (Rotations Per Minute) of Fan

S= 150mm = 0.242sq ft , R = 2000, A=666.66ft

CFM = 3.1416(pi) x (0.5- S) x R x A
CFM = 3.1415 X (0.5 – 0.242) X 666.66
CFM = 3.1415 X 0.258 X 666.66
CFM = 540.332
THE CFM OF FAN IS 540.332

The values of cfm for room and fan which are obtained for the project are

a) The CFM of Selected ROOM IS 533.33

b) The CFM of Fan IS 540.332

The given values are considered per the equations and any changes in it maybe consider the change in the selectivity of the given components.

III. RESULTS

The MQ135 sensor outputs are thus calculated and the filters were found to be effective in various situations as stated under:

	MQ135 output [2] & [8])	MQ135 Output (Proposed)	Place of observation
1.	231	136	Classroom
2.	237	289	Corridor
3.	225	432	Workshop
4.	562(Polluted)	756 (Polluted)	Roadside Area

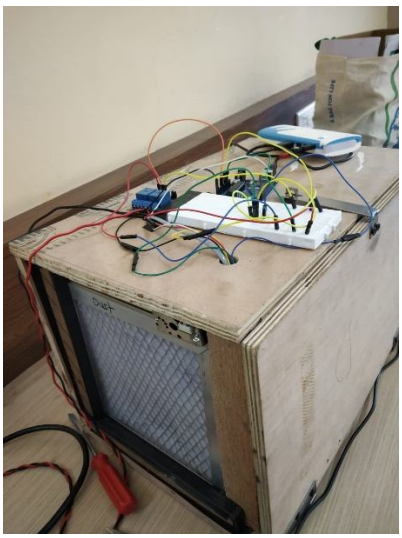

Fig 6. System Showing Output

IV. CONCLUSIONS

This study presents the development of a novel portable air purifier with a set of filters for improvement of air quality inside living rooms and offices. Detailed hardware and software design are shown and experiments in a real world office environment are performed. This study presents the development of a novel portable air purifier with a set of filters for improvement of air quality inside living rooms and offices. Detailed hardware and software design are shown and experiments in a real-world office environment are performed. The Smart Air Purifier was specially designed for old age homes, hospitals, offices etc. This can be used to remove dust, fungus and reducing harmful gases from the air. It is handy and works on direct AC power supply by using an adapter connected to Arduino which works on DC. The technology used in this Air Purifier has a bright future because it works on as and when the dust density is more and thus saves energy. We can thus conclude that the three filters(pre-filter, dust filter & fine filter) were effective in purifying the surrounding air.

A. References (Literature Survey)

Air pollution in large urban areas has a drastic effect on humans and the environment. Ecological issues in India are growing quickly. Air contamination is mainly caused by vehicles and industries which cause various respiratory diseases such as asthma and sinusitis. The quality of air is inferior in metropolitan cities like Kolkata, Delhi, and Mumbai due to a large amount of carbon dioxide and other harmful gases emitted from vehicles and industries.

Examples of reference items of different categories shown in the References section include:

1) We have taken out sensor values of the MQ135 sensor and we got a brief idea on how to build our air monitoring system using wireless sensor networks as specified in paper[1]
2) A brief approach on how to build an Air Purification system using Arduino and Dust Sensor came to us by referring paper [2]
3) Next was a reference journal which tells us about various air filtration technologies and its usefulness in the modern world [3]
4) Example of a conference paper in more details on various air monitoring systems and how IOT can be a useful tool in the implementation of it.[4]
5) We referred a patent which talked about how an Air Filter works and it gave us an insight about how the construction of an actual industrial air filter took place. [5]
6) A detailed description of a Shop Air Filter plan and its design was given in study [6]
7) This paper talks about a model I2P Air Purifier with an Air Quality Monitoring Device. [7]
8) The formula to calculate the CFM of a fan was brought about by a company standard [8]

V. ACKNOWLEDGMENT

Getting a project done reflects the proverbial saying “Success is a marathon and not a sprint”. Dedication and perseverance when supported by inspiration and guidance leads to success. We’re highly indebted to Prof. Lalit Kumar & Prof. Mahesh Kamthe for their guidance and constant supervision as well as for providing necessary information regarding the project & also for their support in completing the Mini Project work. In true sense it was privilege for us to have him as our guide and we felt highly honoured working under him .Prof. (Dr.) V.V Shete, Head, Dept. of Electronics & Communication Engineering, has been a constant source of inspiration to us. Both are responsible for giving us the confidence and courage throughout execution.

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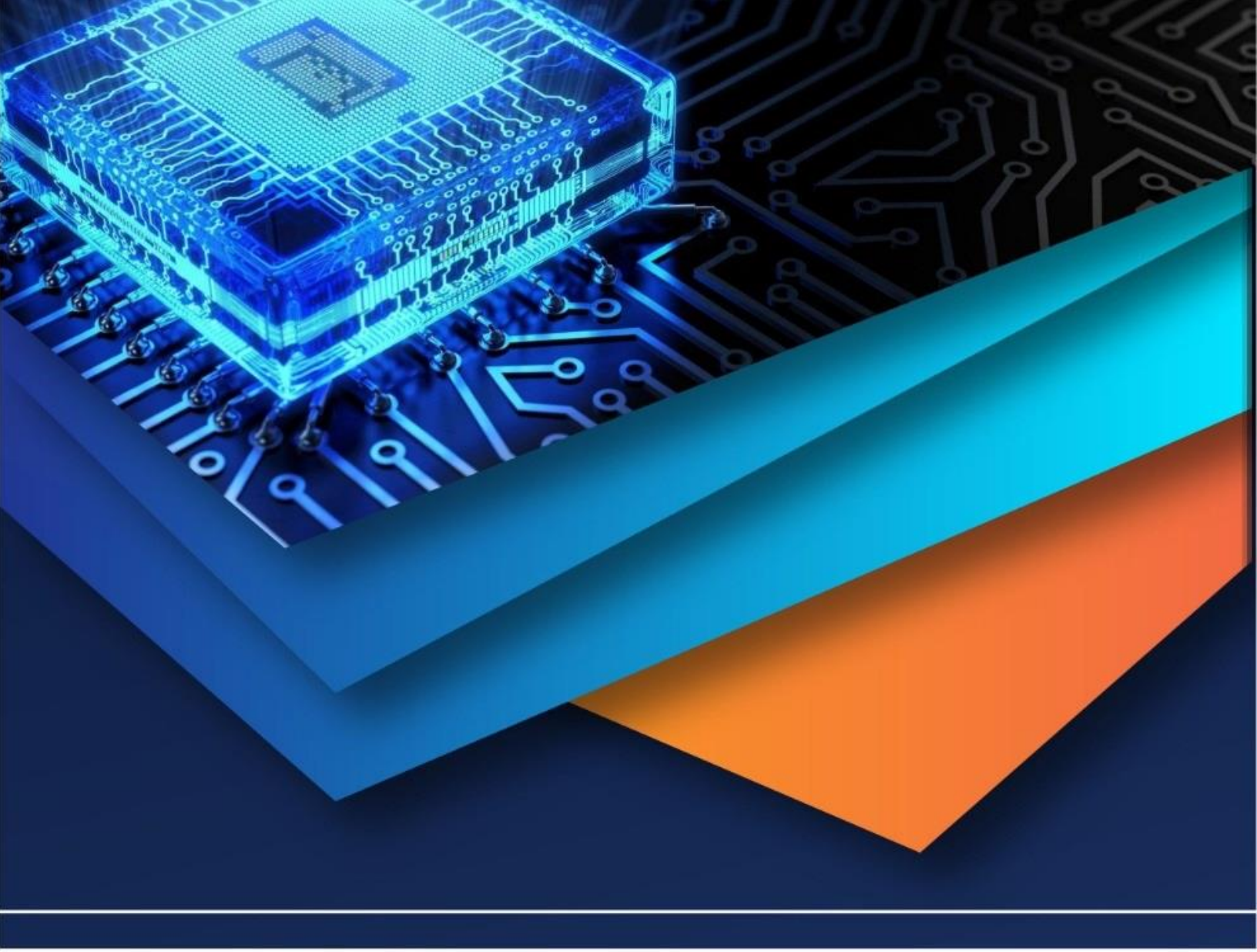
[8] Building Automation Products Inc. UK Ltd: Determining Air Flow in Cubic Ft./Min



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